STRATEGY RESEARCH PROJECT

THE STATE OF THE US ARMY AND SPACE OPERATIONS

BY

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ABSTRACT

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At the end of Operations Desert Shield/Storm, many in the U.S. Department of Defense (DoD) and elsewhere declared the U.S. had won "the first Space War." This study will demonstrate the Gulf War represents an important benchmark for the role of U.S. space systems in support of warfighters. This study will show that while the Gulf War demonstrated the promise of fully integrating space systems into the U.S. joint doctrine and operations, lessons learned in the Gulf War identified shortfalls in planning, doctrine, experience and operations which remain to be addressed. This study explores the importance of space support to U.S. ground warfighters. U.S. military planners have made efforts to develop space policy and doctrine reflecting the end of the Cold War and emerging space systems technology. The study includes a brief synopsis of the emerging doctrine. Since the Gulf War U.S. space force structure modifications and technological developments have progressed. This study will evaluate if these changes successfully overcome Gulf War deficiencies. This study will assess the changing space environment in order to determine if the U.S. is better prepared to employ space plans, doctrine, force structure, experience and systems to support U.S. ground command in likely future conflicts.

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Flush with the outcome of Operations Desert Shield and Desert Storm, many in the U.S. Department of Defense (DoD) and elsewhere declared the U.S. and Coalition forces had won "the first Space War."[1] This study will demonstrate the 1991 Gulf War represents an important benchmark for the role of U.S. space systems in support of warfighters. In the aftermath of what more correctly should be labeled the first "information war",[2] the role envisioned for space systems support to the U.S. military has evolved significantly. This study will show that while the Gulf War demonstrated the promise of fully integrating space systems into the U.S. joint doctrine and operations, lessons learned in the Gulf War identified shortfalls in planning, doctrine, experience and operations which remain to be addressed.

Since 1990 the Army leadership has declared that Army reliance on a systems of systems in space is essential to future victories.[3] This study explores that importance of space support to U.S. ground warfighters. U.S. military planners have made considerable efforts to develop space policy and doctrine reflecting the end of the Cold War and the emerging space systems technology. The study includes a brief synopsis of the emerging doctrine. Since the Gulf War U.S. space force structure modifications and technological developments have progressed. This study will evaluate if these changes successfully overcome Gulf War deficiencies.

While the U.S. has been reacting to the Gulf War's implication for space operations in future warfare, the rest of the world has also noted the same lessons. Proliferation of access to space technology and launch capabilities could provide potential adversaries with increased opportunity to use space-based support for their military activities. This study will assess the changing space environment in order to determine if the U.S. is better prepared to employ space plans, doctrine, force structure, experience and systems to support U.S. ground command in likely future conflicts.

THE ARMY AND SPACE, PAST AND PROLOGUE

The Army's interest in space and space-related technology pre-dates the Gulf War more than half of a century. While the U.S. Army may not always be known as the first to recognize or pursue the value of technological innovation[4], as early as World War I the Army was interested in applying rocket technology to the ground fight.[5] Following World War II, the leadership of the Army sought to have a role in space for military purposes.[6] While there was and still is debate around the use of space for military purposes, U.S. policy eventually included efforts to develop systems; both manned and unmanned, to use space for military purposes.[7]

The Army's history with space-related activities is long but "its involvement in space-related matters has been inconsistent

and often incoherent."[8] The Army's role and influence in space activities declined with the establishment of the National Aeronautics and Space Administration (NASA) and other agencies which then led in space responsibility.[9] Military use of the space programs was molded to fit the Cold War environment.

In the sixties and seventies space systems provided communications, surveillance and reconnaissance support to the military but generally behind a veil of secrecy from the US citizenry.[10] The division of military labor for space activities allocated the US Army Satellite Communications Agency the role of researching and producing both strategic and tactical satellite ground terminals for the services.[11] The Army also was responsible for focusing research and development of air and strategic ballistic missile defense and the tactical application of national space capabilities.[12]

The Army's practical application of space systems to support ground forces began during combat in Vietnam. Use was limited but in Vietnam the military used space-based platforms for weather forecasting, navigation assistance and communications support.[13] Additionally, it is probable that intelligence from space-based systems was provided to government decision-makers and highest level military leaders during the conflict.

As the agencies responsible for developing and fielding the space systems expanded and improved the support available for the

Army, the Army established the Army Space Program Office (ASPO) in 1973 with responsibility for leveraging national capabilities as part of the Joint Tactical Exploitation of National Capabilities (TENCAP) Program.[14] While largely beyond the view of the general public the result was the fielding of a growing number of ever more capable systems to support tactical operations directly and governmental decision-makers that guide military activities.

In the eighties the Department Of Defense established significant force structure for the development and exploitation of space capabilities for military application. In 1985, the US Space Command (USSPACECOM) was established.[15] At the same time development of the Army's Airland Battle Doctrine produced studies showing that space systems incorporating maturing technologies could be used to support many of the Army's missions.[16,17] As a result the Army published an operational concept for space operations, a space architecture and established the Army Space Command as the final component command of USSPACECOM.[18]

These efforts in planning, force structure, doctrine and technological upgrades for military use of space-based systems grew between the Vietnam and Gulf Wars with expanded use in Grenada, Libya and Panama.[19] But the Gulf War was a watershed for such activities.

THE ARMY AND SPACE, THE GULF WAR

In the Gulf War US warfighters were able to use a full array of civil, military, commercial and intelligence satellites for the first time.[20] It was not truly a "space war" since space support was not fully optimized, integrated or coordinated to support surface forces, since there was no direct confrontation between military forces in space,[21] and since there was no direct application of force from space to targets on the earth. Current US space doctrine, adopted largely after the Gulf War, identifies four mission areas for military space functions: Space Support, Force Enhancement, Space Control and Force Application. However, only the first two functions were evident during the Gulf War. A brief synopsis of each area and description of their applicability to the Gulf War[22] will help to demonstrate the status of US military space capabilities in 1991. This is a baseline to judge actions taken in the interim and present capabilities

THE ARMY AND SPACE, GULF WAR REVIEWED

Operation Desert Shield and Desert Storm may not have been the first true space war. However, US and coalition forces did rely upon a range of space-based assets to an unprecedented degree for a wide range of strategic and tactical support functions.[23] Even though a great deal of positive publicity was generated by the Gulf War's leverage of space assets in

prosecuting the war, the military did not rest on its laurels but conducted a critical review of the space community's role and performance during Desert Shield and Desert Storm.[24] Both successes and shortcomings were identified in After Action Reports (AAR) by the supported terrestrial Joint Command, US Central Command (USCENTCOM) and by the principle supporting space Joint Command, U.S. Space Command (USSPACECOM).[25] A detailed analysis of these after action reports as well as other authoritative Department of Defense reviews of the war identifies a large range of shortcomings or issues requiring action. For purposes of this analysis lessons learned will be organized into three broad categories of follow up actions: doctrine, experience and technology.[26] Problems indicating a lack of a codified sanctioned body of published doctrine, directives, manuals, and other published guidance is referred to as "doctrine." Shortcomings leading to or requiring the accumulation of new knowledge, literacy, skill or reorientation is called "experience", while an issue or lesson requiring development and or acquisition of new technology or additional materiel is identified as "technology".

This approach is not unlike many done after the war but it is important to do so with some caution. As one of the better reviews of lessons learned notes "The distinctiveness of the Gulf War places severe constraints on our ability to draw lessons. All wars are unique, but this war--its enemy, its terrain, and a

host of other features--was even more distinctive than most. Whether any major, long-term lessons can be drawn at all from the Gulf War is in fact questionable."[27] One other point to bear in mind, in reviewing the various lists of lessons learned and the analysis by reviewers, it often appeared that an author's experience and organizational perspectives (if not unintentional bias) effected their conclusions and recommendations.

USSPACECOM and its components recognized "a lack of systemic education, training, OPLAN assistance, and an absence of unifying doctrine" all contributed to operational disconnects.[28] "Normalizing[29] space support to the warfighters" is the common theme echoed by the authors of the USSPACECOM AAR.[30] Table 1 illustrates the lessons learned from the viewpoint of the supporting space command and includes the corresponding category in the spacepower development process.[31]

Table 1: US Space Command Lessons

LESSON	CATEGORY
More preplanning required	Doctrine
Supported CINC OPLAN needs work	Doctrine
Include communications requirements in OPLANS	Doctrine
Normalize all space support	Doctrine & Experience
Normalize tactical warning support	Experience & Technology
Operational control of military satellite communication systems remains fragmented	Doctrine & Experience
Maintain the US multi-spectral imagery capability	Experience & *Doctrine or Technology*

Source: USSPACECOM After Action Report, 31 January 1992

The warfighter's perspective of lessons learned differed somewhat from that of USSPACECOM. USCENTCOM developed 500 Joint Universal Lessons Learned (JULL) after the war including many in reference to space support.[32]

Table 2 is a compilation of the USCENTCOM lessons that related to space operations with the corresponding thread of spacepower's development process.[33]

Table 2: US Central Command Lessons

JULL	CATEGORY
Better preplanning required for effective support	Doctrine
Doctrine required on the use of ground mobile force terminals	Doctrine
USSPACECOM Liaison to CINCs required	Experience
Space Demonstration Program	Experience
NMIST critical for timely BDA	Experience
Centralized control of theater communications must be exercised	Experience
Space launch responsiveness	Technology

Source: USCENTCOM After Action Report, 15 July 1991

A third source of lessons learned is the Department of Defense Report to Congress, Conduct of the Persian War: Final Report to Congress. Understandably this report described lessons and observations from the war in a broader context than the two unified commands. Also its authors were more interested in describing weapons and technology than operational concepts.[34] Table 3 illustrates the space-related shortcomings and issues from that report (Volume II, Appendix K) along with the same spacepower development categories used previously.[35]

Table 3: Conduct of the Persian Gulf War: Final Report to Congress (CPGW) Spacepower Shortcomings and Issues

SHORTCOMINGS/ISSUES	CATEGORY
US does not have reactive space-launch capability	Technology
Tactical warning capabilities must be improved	Technology
GPS and most SATCOM are vulnerable to exploitation	Experience
Aging LANDSAT system under Commerce Department control must be replaced	Experience & Technology
DISCS connectivity remained fragile due to age and condition of satellites and ground stations	Experience & Technology
For future operations, planners must consider the challenges of operating within another nations C3 infrastructure	Doctrine & Technology
Military doctrine and training must institutionalize space-based support to operational and tactical commanders and incorporate it into operational plans	Doctrine

Source: CPGW Final Report, Volume II, April 1992

One final review of operations during the Gulf War that provides useful insight into military space-related issues is the Gulf War Airpower Survey (CPGW). This study focuses on describing the "space product" and its operational impact noting five central themes that were not necessarily shortfalls or that required remedial actions.

Table 4: Gulf War Air Power Survey (GWAPS) Central Themes

Theme	Category
Planning and training for use of space systems	Doctrine & Experience
Space mobilization	Technology
Military utility of space systems	Doctrine & Technology
Command and control of space systems	Doctrine
Role of commercial space systems and receiver equipment	Doctrine

SOURCE: Gulf War Air Power Survey, vol. IV

Having acknowledged that lessons learned must be handled carefully; it is still valuable to review the past as you move into the future. The Gulf War provided the first test of space systems supporting warfighters in the post-Cold War era. Valuable lessons identified that technology, experience and doctrine needed enhancement.

THE ARMY AND SPACE, SINCE THE GULF WAR

In the years since the Gulf War the US has initiated numerous efforts to build on the lessons from that war. An analysis of these, using the three development areas employed above demonstrates progress but also unmet objectives.

DOCTRINE

Recognition of the critical role of space systems in support of warfighters has been well documented in US publications since the Gulf War. A succession of key documents reference that importance beginning with the President's National Security Strategy,[36] the National Space Policy,[37]and the National Military Strategy.[38] The Chairman of the Joint Chief of Staff's Joint Vision 2010 discusses leveraging technology for future warfare in terms of new concepts such as dominant maneuver, precision engagement, full-dimensional protection, focused logistics and full spectrum dominance. In every case space systems are envisioned as critical integral components.[39] The Joint Chief of Staff's Concept for Future Joint Operations expands the Vision

2010 theme and notes increased use and exploitation of space systems "will impact all aspects of military operations."[40]

Within the Army, the Chief of Staff of the Army uses Army Vision 2010 to identify concepts for the land component of the joint vision by describing a "set of patterns for operations" that "focus the many tasks armies have always performed in war and other military operations."[41] Each of the six patterns relies explicitly and extensively on space system support.[42]

Specific guidance on how the Army would prepare for such tasks is contained in Army's Training and Doctrine Command (TRADOC) Concept Pamphlet 525-60 Space Support to Land Operations, from 1994.[43] The Concept is a well stated basis for the Army to build a case for a serious Army role in space operations. The concept clearly answers the question of why space operations are essential to the Army's future using the Gulf War as a point of reference. It generally describes the future threat the army will face. It then describes what and how the Army should move forward to be prepared for the future.

FM 100-5 Operations is the basic US Army doctrine document. "As the Army's keystone doctrine, FM 100-5 describes how the Army thinks about the conduct of operations...and undergirds all of the Army's DTLOMS (Doctrine, Training, Leader Development, Organization and Material changes focused on Soldiers)."[44] Army doctrine is an evolving organism impacted by a wide range of

internal and external forces. The current FM 100-5, published in 1993, reflects the Army frame of mind in a new, joint context and a post Cold War strategic environment. This FM acknowledges the role of technology, including space-based capabilities, in shaping the future battlefield. However, the authors of the FM see technology as secondary to doctrine, an enabler that maximizes combat power. They state "the premise that doctrine must be the engine that drives the exploitation of technology".[45] It is this exact relationship which lessons from the Gulf War demonstrated did not exist for space support to land combat forces. FM 100-5 and supporting FMs for Information Operations (FM 100-6) and Space Support to Army Operations (FM 100-18) are intended to be the vehicles to redress the previous failure.

FM 100-6, published in 1996, is the capstone document for Information Operations (IO). It addresses the operational context of IO, relevant terminology and the environment of information operations.[46] Inherently the FM includes discussions of space-based systems in almost every topic due to the pervasive presence of space systems in the fabric of the global information environment (GIE) with its various component parts, including the global information infrastructure (GII), and in the GIE's subordinate Military Information Environment (MIE).[47] However, while numerous, these references to satellites tend to be brief and usually in context with other systems that are parts of larger information systems. This FM does not emphasize the

importance of or the vulnerability of space systems above other components of the MIE. That is left to FM 100-18.

FM 100-18, published in 1995, is easily the Army's single most important statement of space doctrine. A review of its contents will aid in determining how far the Army has progressed in addressing its part of the doctrinal shortcoming so apparent during the Gulf War.[48] This FM quotes Army senior officers in declaring Army policy and objectives for space. It states the impact of space operations on the Army's force projection doctrine while identifying space systems, their capabilities and their limitations. The FM also includes a template for a space operations annex for Army orders, the same annexes that were not existent during the Gulf War. While this FM provides valuable space doctrine it erroneously cites Joint Publication 3-14 as a source for joint space doctrine. That essential document was in final draft when FM 100-18 was published. It is still in draft in 1998.[49] The lack of a unifying source for joint space doctrine has resulted in services each developing respective doctrine without the necessary joint guidance. The FM includes an appendix with a template for developing a space operations annex to operation plans. As noted earlier, lack of such annexes was a serious shortcoming in the Gulf War.

EXPERIENCE

Since the Gulf War various national level and service organizational fixes have been implemented to improve spacepower

experience and to normalize space support to the theater commanders.

At the national level organizations that earlier in the decade had a strategic focus in support of national decision-makers have shifted emphasis in recent years.[50] As an example, even the National Reconnaissance Office (NRO), which was not even acknowledged as an entity a few years ago, "has come out of the closet and they are much more open to releasing intelligence to tactical commanders."[51] Additionally in October 1996 the National Mapping and Imagery Agency was established, in part, as an outgrowth of efforts to improve the dissemination of imagery and geodetic information to tactical consumers. Since the Gulf War the TENCAP (Tactical Exploitation of National Capabilities) Program, well established prior to the war for dissemination of products to tactical units, has expanded "its operation to leverage the billions of dollars spent on National Technical Means."[52]

The Air Force created the Fourteenth Air Force, the Space Warfare Center (SWC), the National Test Facility within the SWC, and the Space Support Team concept.[53] The 1993 stand up the 14th Air Force as the operational space component to the USSPACECOM was the first time Air Force leaders organized spacepower in a familiar manner to mirror the way the rest of the Air Force operated.[54] The SWC, conceived in 1993, is chartered to "refine

doctrine, develop tactics, and formulate concepts and capabilities to better apply space for all warfighters."[55] Collocated with the SWC is the National Test facility where wargaming and analytical capabilities support the SWC and help educate, train and prepare all warfighters for joint warfare by providing space scenarios for military exercises worldwide."[56] Air Force Space Support Teams (SST) from the 14th Air Force, like similar teams of the USSPACECOM, its other component commands and the National Reconnaissance Office deploy to support theater CINCs on a regular basis.[57]

The Army also has made several changes to broaden its support to field units with space-derived information. The Army component of USSPACECOM, US Army Space Command "has really become an operational command. The outfit's complexion has changed."[58] As with other components Army SSTs are increasingly active and have supported numerous CINCs.[59] The Army Space Exploitation Demonstration Program (ASEDP) has been extended with new activities that could lead to future space systems.[60] Also the Army's Space Exploitation Center has grown substantially since 1993. It can now "take promising space technologies, nurture them, then put them in the hands of the warfighter."[61]

TECHNOLOGY

Generally in the area of technology, senior leadership has expanded research and development of new space technologies.[62]

Several technological improvements have addressed shortcomings identified following the Gulf War either as previously planned upgrades or specifics corrective actions.[63] In 1997 the Secretary of Defense stated such improvements are being programmed for future development.[64]

THE ARMY AND SPACE, THE FUTURE

In order to discuss the future role of the Army in space it is necessary to first consider what trends and challenges are emerging. The Army vision of space's future includes global proliferation of information-age technology, precision strike missiles, and weapons of mass destruction. This will increase capabilities for regional powers and increase instability. In the absence of a peer-competitor, "the threat to US forces can still be formidable."[65] In analyzing the future threat in space Army planners find "space systems belonging to the former Soviet Union remain viable and are potentially still the greatest threat to US interests in space."[66] Additionally many other nations and non-nation state actors will develop, acquire or have access to technology and space systems previously available to only a few nations.[67] Army doctrine writers project these hostile forces could possess space control capabilities which "could result in strategic or regional imbalance and instability.'[68] Such capabilities would be even more threatening to the US Army in the future as the number of ground forces decreases and their

dependence on space capabilities grows. Therefore terrestrial and space segments will become very lucrative targets subject to direct and indirect attack. Army documents call for hardening of future space systems and making ground terminals and systems lighter and more mobile.[69] The final threat area addressed within Army concepts for the future is the emergence of Information Warfare and its potential to "overtly or covertly diminish, deceive, or destroy space-dependent information links."[70] In short the future in space could potentially be much more challenging than during the Gulf War.

What should be the Army's reaction to such a future? To begin with, the Army still has a long way to go in bringing the vast majority of its officer and NCO corps into a real appreciation of space's importance to the Army's future. Only recently has the Army made aspects of space policy and operations major parts of Army training and exercises.[71]

Organizationally the Army should support the creation of authority for USSPACECOM to manage a consolidated budget of its own and to have comprehensive acquisition authority for all space related research and development actions.[72] This approach would help solidify the national commitment to space by removing military space-based activities as a pawn to be brokered between and within the service components. Such consolidation would create efficiencies, allow for consolidation of related efforts

and reduce redundancies under a single CINC. Budgetary visibility for efforts to accomplish military space objectives would be clearer so services would not have to attempt to fence moneys within respective service budgets to support programs specifically dedicated to space efforts. Finally this approach would ensure that national space policy and national military strategy were more readily reflected in fiscal and budgetary actions.

At the same time the Army must aggressively pursue a robust space technology program. Since 1995 the Army Science Board has pushed for the Army to do a better job.[73] The board notes that space applications are essential to the Army of the future, the Army must be a smart buyer and exploiter of space capabilities and no other agency is going to invest significantly in capabilities which are outside its own domain. In 1998 the board still identifies failure of the Army to aggressively "identify, assert and influence Army Space Requirements into the design, development and acquisition process of space systems to satisfy Army needs."[74]

The Army must support the broader US effort to insure a viable Space Control capability for USSAPCECOM. The army vision for space in the future foresees that many more actors could have the capability to deny, disrupt or destroy either the space or ground elements of space systems. Therefore the Army has a vested interest in space control.

Since the Gulf War many have argued that the real lesson of Operation Desert Storm was that the US "had to achieve total control of space if it is to succeed on the modern battlefield."[75] The Army should require military satellites and tactical systems be adequately hardened. Hardening is the most cost efficient means to avoid enemy success through asymmetrical attacks by nuclear detonations in low earth orbit that would very seriously degrade US space-based capabilities.[76] It is clear that current national strategy and Army planning for the future assume control of air and space. It is clear also the ways and means for space control do not match this security strategy.[77]

Another area where the Army must lend its support, by identifying its essential requirement for space control, is for the research and development of an Anti-satellite (ASAT) capability. This issue has been a highly political debate since the Kennedy administration.[78] Today's proliferating technology and the real possibility that another nation might field an ASAT create the potential for devastating impacts due to the US military's growing reliance on space in the Information Age. Thus the US must research and develop an ASAT capability with possible deployment if an enemy does develop an ASAT. Also the Army must work with other agencies to identify which of its space-related requirements could best be met through use of commercial space assets, in part or in whole.[79]

The Army must begin these future-looking actions today by tenaciously insuring that surface-oriented requirements for military space systems are forcefully articulated early and throughout the research, development, acquisition and fielding of space systems. The Army must be willing to work in joint forums to insure emerging joint doctrine incorporates ground perspectives. If Army policy makers intend to realize the vision of space included in published doctrine they must identify tradeoffs of resources beginning now.

CONCLUSION

U.S. Army association with space operations has been uneven over the last 50 years. During the Cold War the Army's contributing role was limited and subordinated to civilian agencies. The support the Army received from space was, for the most part, a byproduct of the strategic orientation of national-level organizations charged with exploiting space. By the time of Desert Shield/Storm, with the Cold War waning, a watershed was reached. The Army and operational military forces of all services were provided significant and important support from space as never before.

Desert Storm was not a "space war" because the enemy did not actually use a space based weapon or as a field of battle. U.S. and Coalition military forces received Space Support and Force Enhancement but there were no Space Control or Force Application

operations. However Desert Storm is a benchmark for the role of space operations in support of the U.S. Army. Reviewing the lessons learned in the Gulf War identifies a range of shortcomings in doctrine, experience and technology that precluded complete integration of and realization of the potential for space operations.

Since the Gulf War doctrine has been developed for the Army's role in and use of space operations. The Army has pegged its future victories on the technologies of information dominance and is dependent on space support. All services have developed or improved organizational elements dedicated to space support to the military. Still some basic and essential doctrine remains undeveloped. The lack of overarching joint doctrine may result in Services developing disjointed doctrines. Expertise and experience in planning and "normalizing" space operations has improved markedly since the Gulf War but still is not widely understood by the Army rank and file. There have been technological upgrades of direct support from space to military customers. However most of these were already programmed and represent enhancements planned for Cold War purposes that were modified to serve present and emerging military needs. Today the Army would be better supported from space if it opposed the same enemy it did in 1990.

However the world saw the role space played in U.S. combat during the Gulf War. The growing dependence on space technology

could become a vulnerability as information, space and launch technologies proliferate among potential enemies. To maintain the advantages the U.S. only partially exploited during the Gulf War, the U.S. must make substantial and constant investments in all aspects of space power. The Army must be willing to dedicate the mental energy, personnel, organization and funding to insure that the ground commander's requirements for space support are effectively voiced. The Army must also battle for those requirements to be included in joint research, development and acquisition activities. While insuring ground requirements do not become subordinated to others, the Army must be prepared to support the development of an anti-satellite capability even if it is not fielded until an adversary develops the same capability. The Army must work within the Joint space forum and fully resource this area at the expense of more traditional priorities.

(WORD COUNT: TEXT ONLY 4,751)

ENDNOTES

[1] Among many calling the Gulf War the first space war were:
U.S. Air Force Chief of Staff; General Merril McPeak in Craig Covault, "Desert Storm Reinforces Military Space Directions," Aviation Week and Space Technology April 8 1991, 42.
Cdr. US Air Force Space Command, LTG Thomas S. Moorman, Jr. in "The JDW Interview," Jane's Defence Weekly, 9 February 1991, 200.; as well as Coalition representatives:
Sir Peter B. T. Anson and Dennis Cummins, "The First Space War; The Contribution of Satellites to the Gulf War," Royal United Services Institute (RUSI) Journal, (Winter 1991), Volume 136 No 4: 45-53.

[2]James A. Winnefeld, Preston Niblanck, and Dana J. Johnson, A League of Airman: US Airpower in the Gulf War (Santa Monica, CA: Rand Project Air Force, 1994), 181-184.

[3] General Colin Powell quoted in Center of Army Lessons Learned, Newsletter 91-3, The Ultimate High Ground! - Space Support for the Army Lessons Learned from Operation Desert Storm, (Fort Leavenworth, KS: Center of Army Lessons Learned, October 1991), 1.

[4] Robert L. Stewart (BG, USA Ret.), "New Technology: Another Way to Get Oats to the Horses?", Army 45, no. 1 (January 1995: 27.

[5] David Ritchie, Space War: The Fascinating and Alarming History of the Military Uses of Outer Space (New York: Anthenum, 1982), 18. During World War I Robert H Goddard was employed by the Army to develop a recoilless rocket that a soldier could fire against enemy troops.

[6] Ritchie, 34-38. It was the Army's Redstone Arsenal under the leadership of German scientist Wernher von Braun that took the lead in U.S. missile development for space purposes and successfully launched the first U.S. satellite.
U.S. Department of Army, Field Manual (FM) 100-18 Space Support to Army Operations, (Washington, D.C.: U.S. Department of the Army, 20 July 1995), iii. The Army interest in Space for military purposes began during World War II and was significantly boosted by infusion of German technology and scientists in 1945. Spurred by the Soviet launch of Sputnik, in 1957 the Army oversaw the launch of Explore I following failures by the Navy Vanguard program.

[7] Ibid.

[8] U.S. Army Science Board, Space Systems and Future Army Operations , Ad Hoc Study Final Report (Washington, D.C.: Office of the Assistant Secretary of the Army (Research, Development and Acquisition), April 1995), iv.

[9] U.S. Department of Army, FM 100-18, iii. NASA took the lead as the public focused on manned space efforts that employed military astronauts and the ever larger missiles that were an outgrowth of the military's earlier development of launch platforms for strategic nuclear weapons.

Army Science Board, iv. Even the brightest spot in the Army's history in space, the Army Space Program Office's (ASPO) execution of the Joint Tactical Exploitation of National Capabilities (TENCAP) Program was in large part " a captive to the national (civilian) space program.

[10] David E. Lupton (LTC, USAF, ret.). On Space Warfare: A Space Power Doctrine (Maxwell AFB, AL: Air University Press, 1988), 1.

[11] U.S. Department of Army, FM 100-18 iii-iv.

[12] Ibid.

[13] Frank Gallegos, After the Gulf War: Balancing Spacepower's Development, Research Paper (Maxwell AFB, AL: U.S. Air University, 1996), 2.

[14] U.S. Department of Army, FM 100-18, iv.

[15] Ibid

[16] Ibid.

[17] Henry G. Franke (MAJ, USA), An Evolving Joint Space Campaign Concept and the Army's Role," School of Military Studies Monogram (Ft. Leavenworth, KS: U.S. Army Command and General Staff College, May 1996), 77-78. This reference provides an excellent cross walk of "Space Force Operating Systems" and the Army's "battlefield operating Systems." It demonstrates how totally integrated space support requirements have become to almost all Army combat functions.

[18] U.S. Department of Army, FM 100-18, iv.

[19] Gallegos, 2. "During Operation Urgent Fury in Grenada, US Forces used the Fleet Satellite Communications (FLSAT) and Leased Satellite Communication (LEASAT) Systems in a command and control role for the first time in a joint operation. Operation El Dorado Canyon, U.S. air attacks against Libya, was the first operation in which a space system specifically developed as a TENCAP project was used to support combat operations.

[20] Ibid. "Space-based assets carried over 80% of all messages from the US Central Command's area of responsibility. Satellite intelligence data was essential for planning the air campaign, critical for early warning of SCUD ballistic missile attacks, and aided in determining enemy positions and activities. For the first time in any military campaign, Global Positioning System (GPS) satellites provided precise position information essential to navigation over the almost featureless desert terrain."

[21] Franke, 1.

[22] U.S. Department of Army, FM 100-18, 14-16. and Gregory Billman (MAJ, USAF), "The Inherent Limitations Spacepower: Fact or Fiction?", Research Paper (Maxwell AFB, AL: U.S. Air University), 7-9. Functional definitions below are from FM 100-18 and generally reflect definitions accepted in the U.S. military. The description of Gulf War applications for respective functions are from the Billman paper.

SPACE FORCES SUPPORT

This function is defined as including "forces and activities responsible for launching, maintaining telemetry, tracking, and commanding space systems, recovering spacecraft and providing logistical support for space systems and their ground control elements." The function, addressing the military infrastructure to deploy and maintain military space systems, is primarily the responsibility of the US Air Force with other services assisting as required. During the Gulf War, space support activities that had been in place for Cold War purposes provided, maintained and operated the space systems which provided the force enhancement that many point to as the US first space war victory.

FORCE ENHANCEMENT

This function "includes, but is not limited to, communications, navigation, weather, terrain, environmental monitoring, and surveillance support." The function involves space support that helps the land force accomplish its terrestrial mission and is analogous to combat support. Currently this is the area where Army involvement is the greatest. It was in this area that the greatest impact on the Gulf War was provided by space-based systems which increased effectiveness of *communications, navigation, positioning,*

intelligence and surveillance (including weather) as described below:

- The Defense Satellite Communication System (DISCS) and fleets of spacecraft provided a high data rate, high capacity, worldwide, secure voice communication system for command and control, crisis management, and intelligence data transmission between the field units, theater command structure and the National Command Authority (NCA).

- The NAVISTAR Global Positioning System (GPS) fleet of satellites provided Coalition forces precise three-dimensional location, time information and interfaced with targeting systems to provide highly accurate initial, mid-course and terminal guidance data.

- Intelligence and surveillance support was provided by the US fleet of spy satellites whose names, configurations and specifics are classified. However their products were widely known and included optical, radar and high-resolution images used by US commanders and decision-makers. Additionally space based systems provided valuable information on Iraqi command and control capabilities through Electronic Intelligence (ELINT). Also high quality and rapid Battle Damage Assessment (BDA) was another significant advance credited to space systems. Serious shortfalls in the dissemination system for images, for BDA and other purposes, and not the quality or the existence of the imagery was a lesson learned. One reason the deficiencies were highlighted after the war is that so few warfighters had previous experience with or recognized the value of the imagery beforehand. A final use of space-based surveillance assets, the Defense Support Program (DSP) fleet, was to assist in detecting Iraqi SCUD missile launches.

FORCE APPLICATION

This function "encompasses combat operations from, in or through space with the intent to destroy terrestrial targets" and was not a direct factor in the Gulf War.

SPACE CONTROL

This function is "counter-space operations to ensure freedom of action in space for friendly forces while denying it to the enemy." This function was not a factor in the Gulf War because the enemy was unable or unwilling to contest the issue or even take advantage of space-based capabilities that were available commercially.

[23] Tommy C. Brown (MAJ, USA), Is the U.S. Prepared to Execute Operational Space Control? School of Military Studies Monograph, (Ft. Leavenworth, KS: U.S. Army Command and General Staff College, May 1995), 1.

[24] Theresa M. Phillips (MAJ, USAF), Space Support at the Operational Level: How Have We Learned the Lessons of Dessert

Storm?, Unpublished Paper (Newport, RI: U.S. Naval War College, February 1996) This unclassified study attempted to codify the state of actions by USSPACECOM to address shortfalls/issues identified following the Gulf War from the perspective of a champion for USSPACECOM.

[25] US Space Command, Operation Desert Shield and Desert Storm Assessment (S/NF) (Peterson AFB, CO: USSPACECOM, 31 January, 1992). and

US Central Command, After Action Report Operation Desert Shield/Storm (S/NF) (MacDill AFB, FL: USCENTCOM, 15 July, 1991). These AARs are separate from the Lesson Learned Newsletter cited in footnote 3 above.

[26] Gallegos, 7-13. This approach is borrowed from Frank Gallegos' "After the Gulf War,: Balancing Spacepower's Development." The concept is similar to others such as:

Mackubin Thomas Owens, "Lessons of the Gulf War," Strategic Review, (Winter 1992): 51. Mr. Gallegos' analysis postdates Major Phillips' analysis, cited above. It incorporates more extensive review of lesson learned documentation including the

"Joint Universal Lessons Learned System (JULLS) Database" [CD-ROM], Navy Tactical Information Compendium (NTIC), (Washington, DC: Department of the Navy, December 1994) Disk 2, JULL 92659-18177 and

Conduct of the Persian Gulf War Final Report to Congress, vols. I and II, (Washington, DC: Department of Defense, April 1992), K 50-51.

However their conclusions and resulting recommendations are similar with differences growing out of their varying approaches and the objectives of their research.

[27] James Blackwell, Michael J. Mazarro and Don M. Snider, The Gulf War: Military Lessons Learned (Washington, D.C.: The Center for Strategic and International Studies, July 1991).

[28] Phillips, 7.

[29] Ibid. "Normalizing" roughly means launching and operating space systems as matter-of-factly and as purposefully as it does aircraft and then treating those space systems as workaday and warfighting tools and not as showpieces in the sky.

[30] Gallegos, 7.

[31] Neither USSPACECOM nor USCENTCOM had fully anticipated or planned for the important support to warfighters that space systems could play in place of USSPACECOM's traditional *strategic*

mission. Neither had made the doctrinal or mental shift from a Cold War space philosophy. The call for "normalization" equates to the development of doctrine so that forces may organize, train, and equip to prepare for the future absent the Cold War paradigm. From USSPACECOM's perspective these lessons reflected the fact that because the supported command had not anticipated the role space assets were to play in the war there were no properly prepared plans or trained personnel to use the assets. There was no space annex to the war plan and key ground components of the space systems were left off the Time-Phased Force Deployment List (TPFDL). Operational control of several military satellite communication systems created confusion and highlighted the need for a centralized satellite communication structure in peacetime and war. Multi-spectral imagery (MSI) proved to be very useful to the warfighter. However, the US had only one organic source, the aging, US Commerce Department controlled Land Satellite (LANDSAT) System. The US was dependent on the French commercial system satellite por l observation de la terre (SPOT) system.

[32] Gallegos, 7.

[33] USCENTCOM recognized how little useful military space doctrine existed at the time. The six-month build-up provided time to develop work-arounds. However such a luxury should not be expected the next time and viable joint space doctrine must be developed and understood by warfighters. Also doctrine needed to be reviewed in light of the shortages that US VII and XVIII Corps experienced in ground mobile satellite communication terminals. USCENTCOM responded to a lack of experience with space capabilities and with support procedures by seeking expertise through USSPACECOM liaison, National Military Intelligence Support Teams (NMIST), Space Demonstration Program. As noted before, the next time there may be no opportunity to develop such experience, so it must be developed beforehand. Within the theater, satellite communication was fragmented until USCENTCOM assumed control for validating all long haul strategic communications. Such actions prevented early deploying units from using all available resources before hostilities and validated the importance of centralizing control of theater communications. The final lesson reflects USSPACECOM's lack of a booster to meet requirements to accelerate the launch of a badly needed DISCS satellite. The US inability to launch in a short time period was deemed a serious weakness to be addressed by technology.

[34] Gallegos, 13.

[35] The lack of a responsive launch capability is noted. The report noted the work-arounds for theater ballistic defense using the DST to detect SCUD launches but stated the need for improved technology to solve the warning problem by replacing the DST with an improved sensor. Although no threat existed or was employed by the enemy, the report confirmed the military community's call for the production, distribution and integration of GPS receivers incorporating selective availability decryption. The report also found the Gulf War proved the value of fielding the MILSTAR satellite system and installing anti-jam modems for super high frequency (SHF) fixed-based satellite terminal and tactical ground mobile terminals. The authors opined the older DISCS satellites and ground terminals require modernization and an increase in the number of military satellites providing worldwide command and control coverage. The final finding underscores the need to move from the Cold War strategic doctrine to a new doctrine for operational space support to tactical commanders.

[36] The White House, A National Security Strategy For a New Century (Washington, D.C.: U.S. Government Printing Office, May 1997), 14. The strategy states "We are committed to maintaining our leadership in space."

[37] National Science and Technology Council, National Space Policy (Washington, D.C.: U.S. Government Printing Office, September 1996), 3-6. This document specifies that "Improving our ability to support military operations worldwide...{is} a key priority for national security space activities."

[38] The Joint Chiefs of Staff, National Military Strategy (Washington, D.C.: The Joint Staff, Undated). Disappointingly the strategy makes little specific reference to military space operations. Implicitly space systems will play essential roles supporting many aspects discussed in the strategy. The one exception is a specific statement stressing the need for space control due to the importance of space to joint operations.

[39] The Joint Chiefs of Staff, Joint Vision 2010 (Washington, D.C.: The Joint Staff, Undated), 11-27.

[40] The Joint Chiefs of Staff, Concept for Future Joint Operations : Expanding *Joint Vision 2010* (Washington, D.C.: The Joint Staff, May 1997), 24.

[41] U.S. Department of Army, Army Vision 2010 (Washington, D.C.: U.S. Department of the Army, Undated), 10.

[42] Ibid. 11-17.

[43] U.S. Army Training and Doctrine Command. Training and Doctrine Command Concept Pamphlet (TRADOC PAM) 525-60. Space Support to Land Force Operations (Fort Monroe, VA: Headquarters U.S. Army Training and Doctrine Command, November 1994). The purpose for the Concept is to be "the basis for the development of doctrine, training, leader development, organizations and material changes focused on soldiers (DTLOMS) requirements and solutions for operation enhanced through the use of space capabilities." The concept is "to use space systems and capabilities to enhance the Army's ability to execute force-projection operations doctrine as stated in FM 100-5. as well as emerging doctrine per TRADOC Pamphlet 525-60."

The Concept document opens with a bold statement of ARMY SPACE POLICY signed by the Secretary of the Army , "Future success of Army forces will be critically dependent upon exploitation of space assets, capabilities and products....The Army's future is inextricably tied to space." The stated purpose of this concept was to describe space capabilities the Army should exploit and integrate into all Army operations and to provide "the framework to normalize the use of space in land force operations. A need of such normalization was a major lesson learned in the Gulf War.

The pamphlet includes a lengthy answer to the question of "Why The Concept Is Needed." The answer provides an official explanation of the value of space systems to the Army. It is also an argument of why it is important for the Army to embrace a growing role of space in Army doctrine, force structure and operations. The pamphlet views space as a new dimension to the traditional battlefield and an enhancement to US warfighting capabilities. The document states that space has been part of US force structure for four decades in war and in operations other than war but only now with an increasing appreciation by the Army for the contribution of space's capabilities to land force operations. In peering into the future, power projection battlefield the authors see space capabilities enhancing land force dominance in many ways. The authors explain how space support will apply at each of the three levels of war. At the strategic level through supporting global projection with space-based indicators and warning. For the operational level by focusing formidable assets on the theater of force projection. At the tactical level of ground projection by fully appreciating resources available to support a particular event or region. Future operations are envisioned as being short notice, regional in nature, possibly in strange areas with little or no US forward presence and limited infrastructure, joint, combined, in coalition and interagency. The future Army "will likely be a smaller force with more varied missions, all in the midst of increasing uncertainty." In short the document recognizes that

"In the post-Cold War era, the Army's effect use of space capabilities is as critical to global operations as land, sea and air capabilities have been in the past."

One of the lessons from the Gulf War was the need to shift thinking about space from the strategic Cold War perspective. This Army concept makes that shift, "The Army must fully exploit the data provided from strategic design systems, and look for new ways of using that data for tactical application, hence, new technologies applied to ground forces...regardless of the intent for which these space systems may have been originally designed."

The concept also describes the changed threat in the future, a period of uncertainty. (Proliferation of information-age technology to include precision strike missiles and of weapons, including those of mass destruction means increased capabilities for regional powers and increased instability. In the absence of a peer-competitor, "the threat to US forces can still be formidable."

In analyzing the future threat in space the pamphlet finds "space systems belonging to the former Soviet Union remain viable and are potentially still the greatest threat to US interest in space." Additionally many other nations and non-nation state actors will develop, acquire or have access to technology and space systems previously available to only a few nations. The authors project these hostile forces could possess space control capabilities which "could result in strategic or regional imbalance and instability.' Such capabilities would be even more threatening to the US in the future as ground force dependence on space capabilities grows. Therefore terrestrial and space segments will become very lucrative targets subject to direct and indirect attack. The document called for hardening of future space systems and making ground terminals and systems lighter and more mobile. The final threat area addressed within the concept is the emergence of Information Warfare and it potential to "overtly or covertly diminish, deceive, or destroy space-dependent information links."

Chapter 3 of the pamphlet, *Concept*, details the concept. After defining the space mission areas in joint terminology the concept calls for an evolutionary integration for space support into all Army operations in three phases. The first, "near-term of quick fix phase (POM years)," in which the Army leverages current systems and capabilities. The "mid-term phase (POM years plus ten years," the Army promoting developing and/or acquiring processors with more direct interface with space systems. And finally the "far-term or objective phase (beyond the mid-term period) in which the Army promotes influencing the design of space systems to ensure Army specific requirements are being addressed during early design phase for joint and national systems. For each phase the discussion identifies actual systems (for the first phase) or functional capabilities the Army will

require in the future. Then required space-based capabilities are linked to the Army's doctrinal stages of FM 100-5 for each of the three time phases. In each case the near term discussion are more specific while the latter two phases are in terms of functional capabilities.

Chapter 4 of the Concept, *Impact*, describes how the "Army must do all that it can to shorten the timelines for implementing changes to DTLOMS, in response to rapidly advancing information technology."

[44] U.S. Department of Army, Field Manual (FM) 100-5 Operations (Washington, D.C.: U.S. Department of the Army, 14 June 1993), v.

[45] Ibid. 2-3.

[46] U.S. Department of Army, Field Manual (FM) 100-6 Information Operations (Washington, D.C.: U.S. Department of the Army, 27 August 1996), iii.

[47] Ibid, 1-2 - 1-4. Defines the terms as:

GIE "includes All individuals, organizations, or systems most of which are outside the control of the military or National Command Authorities, that collect, process and disseminate information to national and international audiences."

GII is "an interconnection of communications networks, computers, data bases, and consumer electronics that outs vast amount of information at the user's fingertips...a worldwide, seamless, dynamic web of transmission mechanisms, information appliances, content, and people."

MIE is "The environment contained within the GIE, consisting of information systems and organization--friendly and adversary, military and nonmilitary, that support, enable or significantly influence a specific military operation."

[48] U.S. Department of Army, FM 100-18. This FM is filled with strong statements of the criticality and importance of space to the Army, including several attributed to the then Chief of Staff of the Army, meant to insure Army readers understand that space operations are in the Army's future in a big way. It refers in brief terms to National and DoD Space Policies as a basis for proclaiming the resulting Army Policy.

As an intermediate step the FM addresses guidance from the Joint Chief of Staff (JCS). Erroneously the FM states the JCS Pub 3-14 "provides the doctrine and principles by which military forces should plan, prepare, and execute military space operations." At the time the FM was published JCS Pub 3-14 was in final draft. This critical item of doctrine remains

unpublished in 1998. JCS Pub 0-2 is then quoted to enumerate the Army's responsibilities for space operations.

Having referenced higher policy, Army policy "articulates the Army's position and serves as a framework for the Army's future direction in space based on the premises that space based products are becoming an increasingly important element of successful military operations." The Army space objectives are established:

- Accessing national, civil, military, allied and commercial space products.
- Exploiting space-based assets, capabilities, and products.
- Conducting space and apace-related activities that enhance operational support to warfighters.
- Organizing and training forces to take full advantage of space-based capabilities.

The Army policy clearly views space's potential capabilities as a means to support ground missions, "to support operations and maintain land force dominance well into the twenty-first century." The implementation strategy to fulfill these objectives is summarized in terms of three concurrent phases. The phases are: (1) near term - acquire receivers to use and leverage extant space system capabilities; (2) mid-term - acquire or develop processors for better integration and direct interface with space systems; and (3) far term - influence development of future space systems with specified Army requirements.

The remainder of the FM details the impact of space on future Army operations stressing the evolving role of a force projection Army in the post Cold War environment. The FM methodically ties space to many of the well-known, pervasive aspects of broader Army doctrine.

Chapter 2, *Impact of Space on Force Projection Army Operations*, relates space's value added to the Army's characteristics, addresses the relationship between space and the Army's tenets of operations, and discusses the impact of space on each of the Army's combat functions. Chapter 3, *Use of Space Systems*, specifies how the Army plans for and applies space systems and their capabilities to support the full range of Army operations within a joint context. It uses joint terminology to describe the four military space functions and general planning consideration for space support from the strategic to the tactical level during each phase of operations.

Chapter 3 also describes the 1993 Army organizations, operations and programs designed to implement the doctrine. Additionally the chapter stresses training for the use of space, applying the standing calls "to train as we fight and to train to high standards." Chapter 4, the final chapter, *Space System Capabilities and Limitations*, considers space capabilities within major functional areas and their general limitations. Unlike Chapter 3's operational context, capabilities are tied to space

systems in terms of functions such as communications; reconnaissance, intelligence, surveillance, and target acquisition (RISTA); weather, terrain and environmental monitoring; position and navigation, and missile warning. In describing space systems, three segments are identified: "a space segment--the satellites; a control segment--ground stations and managers; and a user segment--the equipment necessary to receive the satellite signals". System limitations are listed to identify areas that Army users must consider when planing and requesting space support. They include access, vulnerability, and utility.

One of the annexes to the FM is a template for developing space operation annexes to operational orders.

[49] Joint Chiefs of Staff, "Joint Pub Status," 6 April 1998; available from <http://www.dtic.mil/doctrine/stat314.htm>; Internet; accessed 6 April 1998.

[50] Phillips, 5-6. "...control and use of national systems and derived intelligence products is divided among the NRO, Central Intelligence Agency, [National Mapping and Imagery Agency], and National Security Agency."

[51] James Kitfield, "Space War II." National Journal 27, no. 51-52 (23 December 1995): 3142.

[52] Gallegos, 22.

[53] Ibid., 24.

[54] Ibid., 24.

[55] Ibid., 24-25.

[56] Ibid., 25.

[57] Phillips, .9-10. and
Gallegos, 25.

[58] William Scott, "Army, Navy Space Resources Focus on Tactical Support," Aviation Week & Space Technology 147, no 9 (1 September 1997): 56.

[59] Ibid.

[60] Ibid. ASEDP was originally established to focus on introducing commercially available space-based tools to

operational units. Today ASEDP has expanded to conduct overseas experiments and technical evaluations. ASEDP was responsible for the fielding of small weather receivers, MSI workstations and lightweight "Slugger" GPS receivers. LTG Garner, Commander of the Former Army Space and Strategic Defense Command cites the latter, the Small, Lightweight Global Positioning System Receiver (SLGR) as an ASEDP success story with its introduction to the Army during the Gulf War.

[61] Ibid.

[62] Gallegos, 21.

[63] Ibid. Systems providing direct weather satellite imagery at the tactical level have already been fielded in Korea and in Bosnia. The 11th Space Warning Squadron has begun operations of the Attack and Launch Early Reporting to Theater (ALERT) system. This system is a technological attempt to normalize and improve tactical warning support to warfighting CINCs by providing better ways to use the Defense Support System satellites for operations such as finding SCUDs in Iraq. Programs to field a GEOSAT Follow-On system will provide real-time oceanographic topographic data to naval users. Additionally development proceeds for the systems [Milstar, Fleet Satellite and UHF Follow On (UFO)] to enhance UHF and EHF communications for mobile forces by providing jam resistant, survivable and enduring connectivity for the most critical command and control messages. This marks an important expansion of communications means that were reserved for strategic purposes during the Cold War. Additionally, since the Gulf War, DoD has begun a program to improve the Global Broadcast System using already planned upgrades to the UFO system in order to provide nearly worldwide, high-data rate capability to the lowest echelon forces as unprecedented access to national and theater information.

Secretary of Defense, Annual Report to the President and the Congress, (Washington, D.C.: U.S. Government Printing Office, April 1997): 204-206. Some examples for the Army include : 1) The first Small Tactical Terminals, providing direct weather satellite imagery at the tactical level, were fielded in Korea and Bosnia in 1996, addressing a shortfall in the timely receipt of high-resolution weather data noted in the Gulf War; 2) In 1994 the launch of Milstar and subsequent initial operational capability in 1995 means strategic users can transition from the DSCS satellites freeing substantial tactical capability on DSCS, again addressing a shortfall of military satellite communication capability from the Gulf War; 3) In 1996 an effort was begun to update the Global Broadcast system (GBS) using already planned UHF Follow-On (UFO) system as a host to leverage commercial direct broadcast capabilities on the high data rate link program

needed to support the warfighter; and 4) The Air Force has fielded Attack and Launch early Reporting to Theater (ALERT) in 1995 which normalizes and improves tactical warning support to warfighting CINCs, improving on the Gulf War's ad hoc system based on the Defense Support Program satellites.

[64] Secretary of Defense, 206.

[65] U.S. Department of Army, TRADOC Pamphlet 525-60, 4.

[66] Ibid. 4.

[67] Army Science Board, APR 95, 27-57. and
Army Science Board, APR 95, 14. The ASB identified a "radical shift in geo-political threat environment" which emphasizes "new Army reliance on space systems." The ASB stated the shift would mean the Army would need to become increasingly dependent upon space capabilities and space systems are the basis for Army information systems. The figure below summarizes the paradigm shift:

Table 5: Paradigm Shift: Operational Considerations

FACTOR	**OLD**	**NEW**
ADVERSARY	KNOWN	NOT EASILY PREDICTED
LOCALE	WELL UNDERSTOOD	UNCERTAIN
THEATER SIZE	MODERATE	POSSIBLY LARGE
INDICATORS & TARGETS	DEVELOPED DATABASE	POORLY KNOWN
TACTICS	DEFENSIVE POSTURE	INITIATIVE, MANEUVER
PREHOSTILITY PACE	RELATIVELY SLOW	RAPID CHANGE
TARGETABILITY	LARGELY ARMY	JOINT
GENERAL CAPABILITIES	LARGELY SPECIFIC	FLEXIBLE, RESPONSIVE

[68] U.S. Department of Army, TRADOC Pamphlet 525-60, 4. The authors describe such capabilities as "co-orbital anti-satellite (ASAT) capabilities, direct assent, ground attack, sabotage, electronic warfare (EW), directed energy, and nuclear detonation to deny/disrupt the US and it allies use of space systems."

[69] Ibid.

[70] Ibid.

[71] Bill Gregory, "Leveraging Space Investments: High Cost of Space Programs Drive New Partnerships," Armed Forces Journal International (August 1997): 36-37. The Army-After-Next Winter Wargame at the Army War College in February 1997 represents the

first time space capabilities were "included as major aspects, not adjuncts" in such an event.

[72] Gary E. Heuser (LTC, USA), The Army and Military in Space" AWC Study Project, (Carlisle Barracks, PA: US Army War College, 1993) 22-23.

[73] Army Science Board, APR 95 A-III-3 through A-III-7. The ASB reviewed current space systems and future space systems in terms of the Army contribution to and role in Research, Development and Acquisition. They concluded "the Army has not been a strong player in the formulation of the systems and programs, that the Army has not exploited the systems and programs exceedingly well (with few exceptions), and that in only a few areas has the Army been productive in the development and operational utilization of ground terminals and processors."

[74] Army Science Board, "Army Science Board Summer Study," lecture, Crystal City, VA, U.S. Army Space and Missile Defense Command, February 1998, approved for public release.

[75] Colin S. Gray, "Space Power Survivability," AirPower Journal (Winter 1993): 27.

[76] R. C. Webb, "Nuclear Threats to Low Earth Orbit Satellites," lecture, Carlisle Barracks, PA, U.S. Army War College: Center for Strategic Leadership, 23-25 March 1996 Strategic Crisis Exercise 1998, approved for public release.

R. C. Webb, Lew Cohn and Joan Perre, "The Cost Differential to Harden DoD Space Assets," lecture, USAF Academy, 27 March 1996, approved for release. This study reports that low yield detonations in low earth orbits (LEO) would disrupt space systems and effected tactical ground systems immediately following the detonations ("prompt effects). Additionally such detonations would degrade unhardened LEO satellites as they repeatedly crossed through residual radiation that would accumulate in magnetic belts surrounding the globe. The study shows that the costs for minimal hardening to offset High Altitude Electromagnetic Pulse (HEMP) would be small percentages (1 to 5%) of the cost for the satellites or tactical ground systems.

[77] Matthew F. Martorano (LTC, USAF), "Space Control Strategy for a Dynamic, Multipolar World," AWC Strategy Research Project, (Carlisle Barracks, PA: US Army War College, 1997), 12-14. Currently the US relies on negotiation of treaties or deterrence through the threat of conventional ground attack. This observation was demonstrated during the March 1998 US Army War College's Strategic Crisis Exercise.

[78] Martorano, 20.

[79] Gregory, 34.

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